Report of GGOS

presented by

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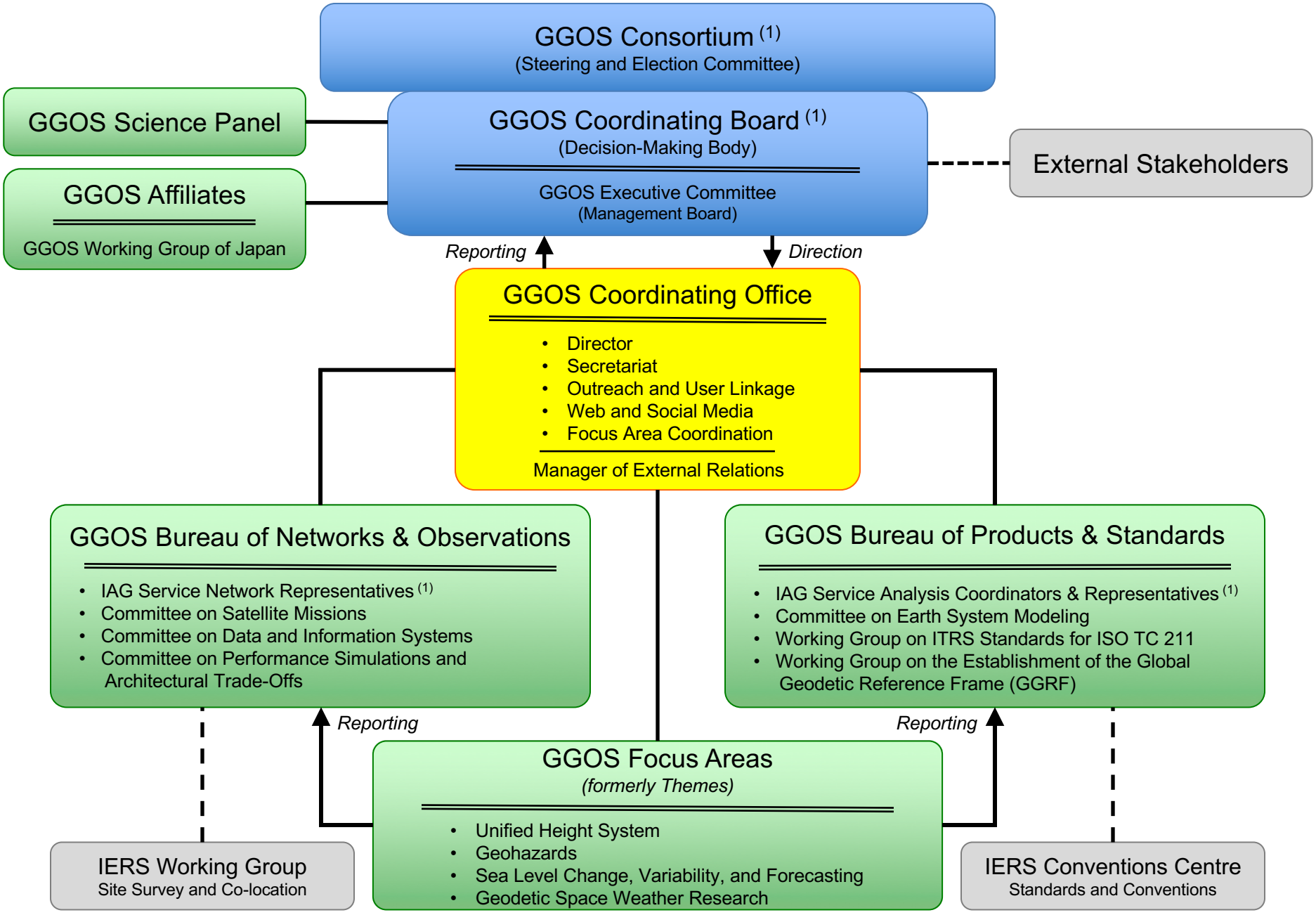
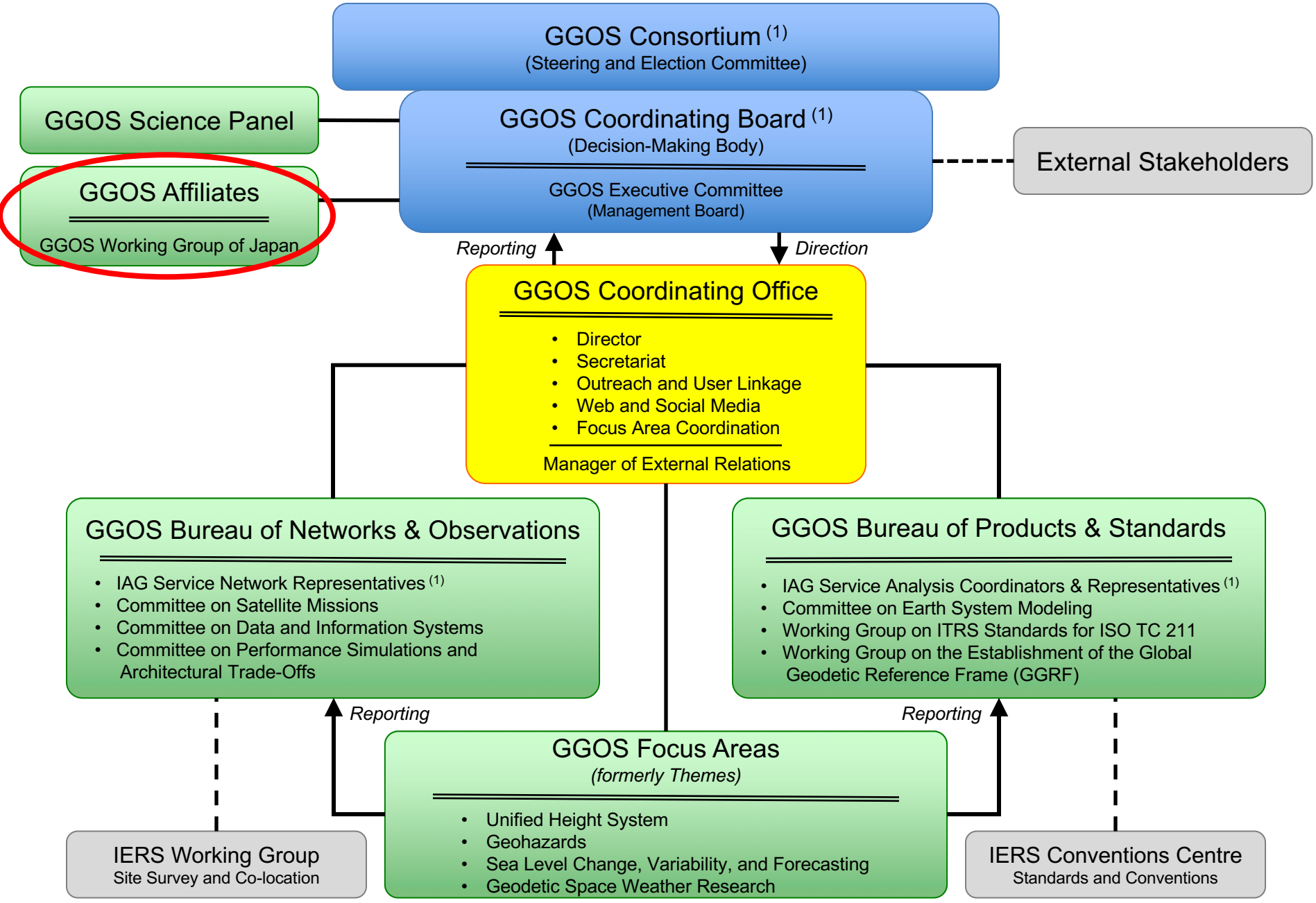
Pasadena, CA 91109–8099, USA

International Association of Geodesy
Executive Committee Meeting

April 13, 2018
Vienna, Austria



(1) GGOS is built upon the foundation provided by the IAG Services, Commissions, and Inter-Commission Committees



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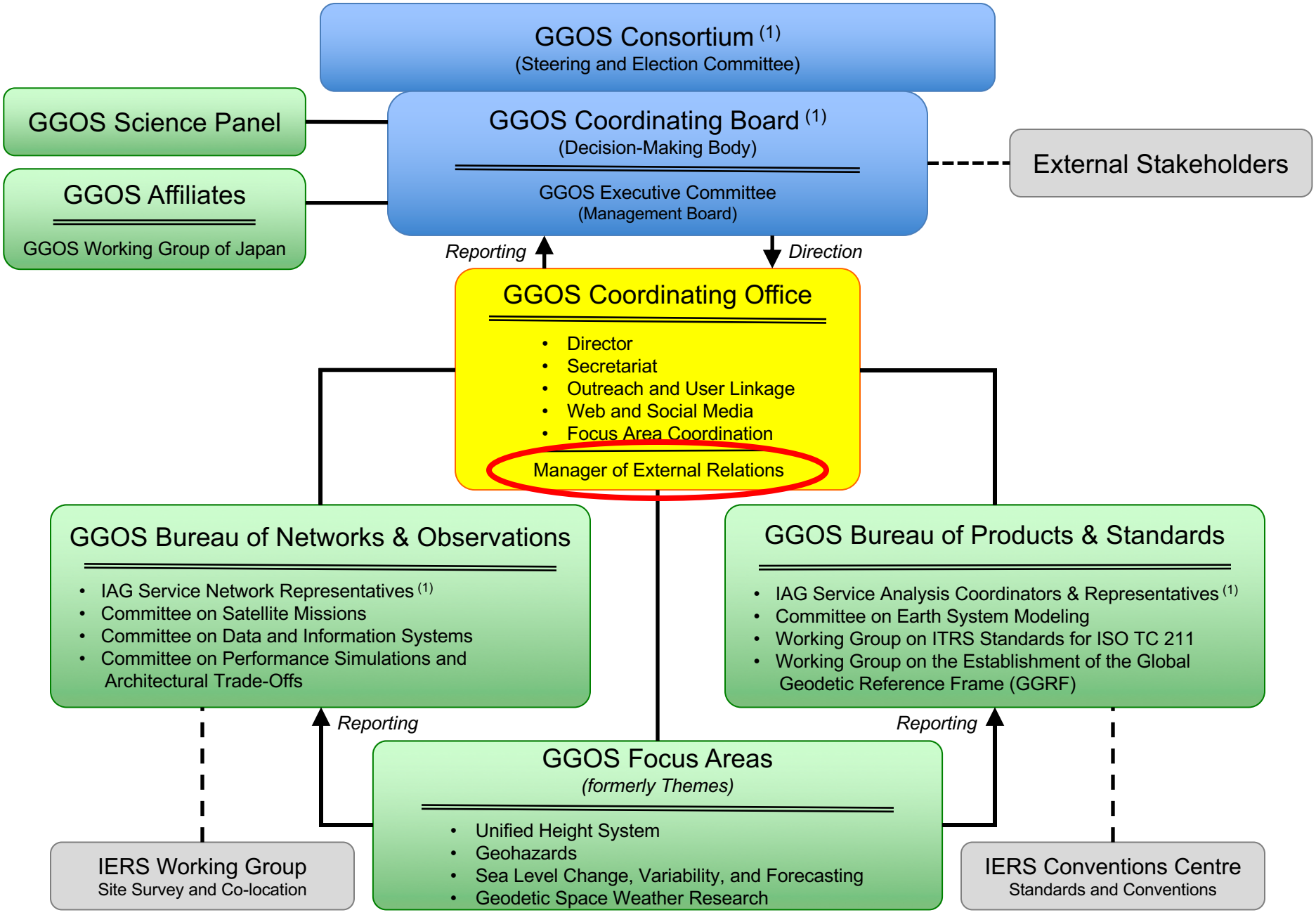
GGOS Affiliate

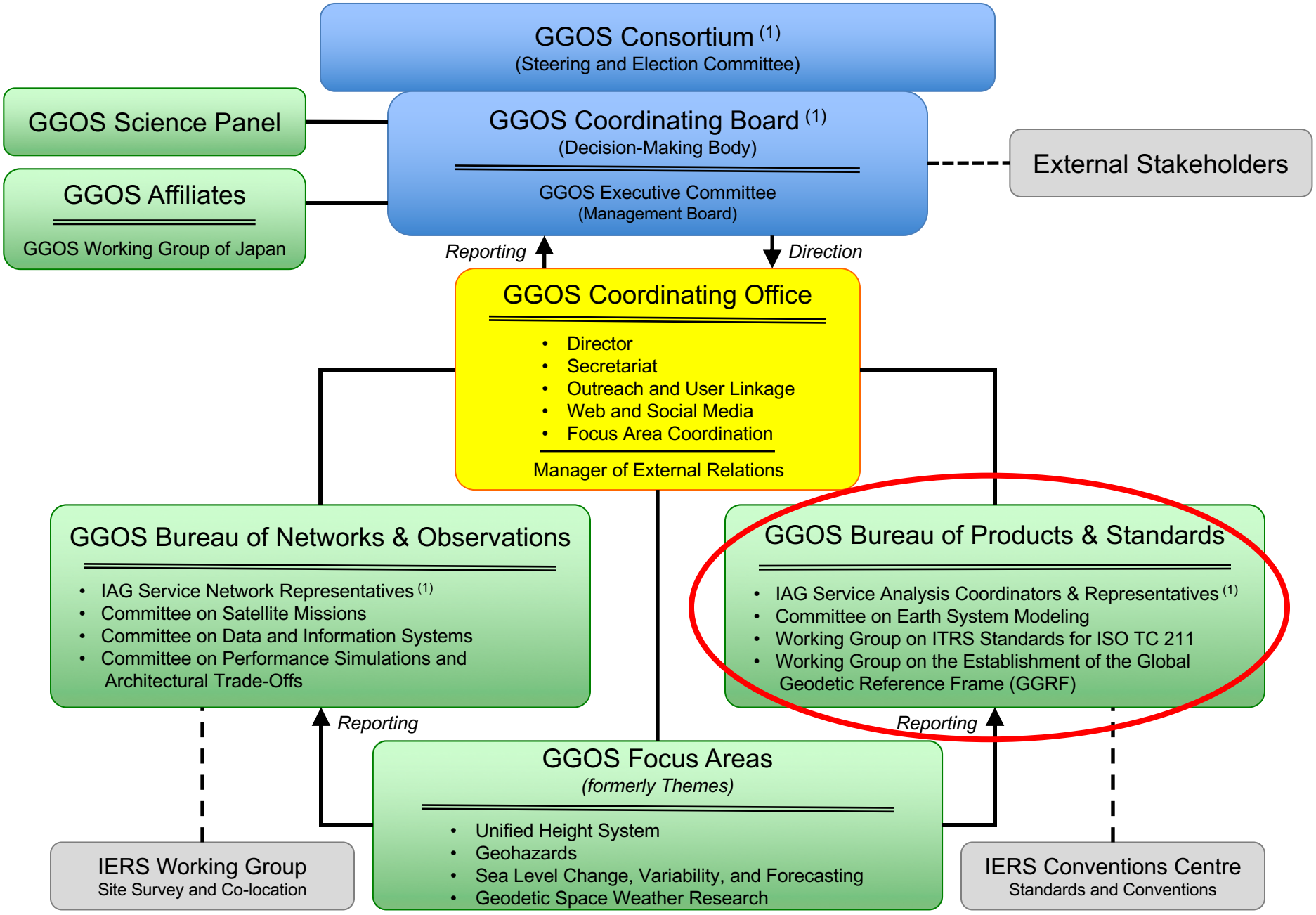
- National or regional organization
  - That coordinates space-geodetic activities there
- Established to increase participation in GGOS
  - Particularly from under-represented areas
    - Africa, Asia, South and Central America
- Is a component of GGOS
  - With representation on Consortium and Coordinating Board
    - Each GGOS Affiliate has 1 representative to Consortium
    - Collectively they have 2 representatives to Coordinating Board
- First GGOS Affiliate
  - GGOS Working Group of Japan
    - Established in 2013; Chair: Toshi Otsubo of Hitotsubashi University, Japan
    - Provides forum for multi-technique, space-geodetic discussions within Japan
    - Strives to improve quality of observations & encourage collaboration in Japan
- Encourage others to become GGOS Affiliates
  - Particularly important for nations/regions where multiple agencies own space-geodetic equipment



(1) GGOS is built upon the foundation provided by the IAG Services, Commissions, and Inter-Commission Committees

Manager of External Relations

- Expanding involvement in external organizations
  - Group on Earth Observations (GEO)
    - GGOS Chair appointed to GEO Programme Board for 2018-2020
  - Committee on Earth Observation Satellites (CEOS)
    - Limited participation at present
    - Should be expanded to complement GGOS participation in GEO
  - UN-GGIM Subcommittee on Geodesy
    - Will establish an appropriate governance mechanism for sustaining GGRF
- Requires better approach to managing activities
  - Past approach rather *ad hoc* in nature
    - Volunteer-based
    - Little long-term stability in representation
- Position of Manager of External Relations created
  - To coordinate GGOS engagement with external organizations
    - Resides within GGOS Coordinating Office
    - Appointed by GGOS Chair subject to approval by GGOS Coordinating Board
    - Member of Coordinating Board and Executive Committee
- Allison Craddock selected as first Manager



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Essential Geodetic Variables

- Observed variables
  - Crucial to characterizing geodetic properties of Earth
  - Key to sustainable geodetic observations
    - Positions of reference objects (ground stations, radio sources), EOPs
    - Gravity measurements (ground-based, space-based)
- Assign requirements to each EGV
  - Accuracy, spatial and temporal resolution, latency, stability, …
- Derive requirements
  - On EGV-dependent products (TRF, CRF, …)
  - On infrastructure (observing systems)
- Can be used to update GGOS2020 book
  - Bottoms-up approach to deriving requirements
    - Complements top-down approach used in GGOS2020 book (user needs)
- Establish Committee within GGOS BPS
  - To create list of EGVs, assign requirements to them, etc.
  - Committee will include representatives of
    - IAG Services, Commissions, Intercommission Committees, GGOS Focus Areas

Revisions to Terms-of-Reference

- Manager of External Relations
  - Add description of Manager
    - Roles and responsibilities; selection process
- GGOS Affiliates
  - Add description of GGOS Affiliate
    - Representation on Consortium, Coordinating Board
- Science Panel
  - Add that each Focus Area nominates 1 candidate
    - Corrects omission to ToR that were approved in Prague
- GGOS Inter-Agency Committee
  - Remove references to GIAC which has been dissolved
    - GIAC has been effectively replaced by the UN Subcommittee on Geodesy
- UN-GGIM and Subcommittee on Geodesy
  - Add description as fundamental supporting element of GGOS
- GGOS Chair
  - Give in more detail process by which GGOS Chair is selected
    - Consistent with changes to be made to IAG Bylaws

Science Panel Members

IAG Commission 1
Geoff Blewitt (USA)
Markus Rothacher (Switzerland)

IAG Commission 2
Thomas Gruber (Germany)
Kosuke Heki (Japan)

IAG Commission 3
Jianli Chen (USA)
José Ferrándiz (Spain)

IAG Commission 4
Pawel Wielgosz (Poland)
Jens Wickert (Germany)

IAG ICC Theory
Mattia Crespi (Italy)
Yoshiyuki Tanaka (Japan)

GGOS Focus Area 1
(Unified Height System)
Bernhard Heck (Germany)

GGOS Focus Area 2
(Geohazards)
Diego Melgar (USA)

GGOS Focus Area 3
(Sea Level Change)
Don Chambers (USA)

GGOS Focus Area 4
(Space Weather Research)
Ehsan Forootan (UK)

Coordinating Office – recent activities

- Process enhancement
  - Surveymonkey for elections
  - GoToMeeting for all meetings
- Meetings
  - GGOS Days, Vienna
  - GEO XIV. Plenary, Washington, DC (Exhibition booth)
  - AGU Fall Meeting, New Orleans
- Outreach/Public relation
  - Webpage updates (Content, Calendar, File Cloud)
  - GGOS Brochure, Logos
  - GGOS Posters (e.g. Geohazards)
- External relations
  - New position within CO: Allison Craddock

Slide provided by Matthias Madzak

GGOS External Relations

GGOS External Relations Near-Term Goals

Connecting GGOS with the United Nations

UN World Conference on Disaster Risk Reduction
2015 Sendai Japan

There is tremendous potential to increase the exposure and impact of GGOS by identifying potential contributions and connecting existing relevant work to efforts in support of both UN SDGs and the Sendai Framework.

GGOS has the potential to facilitate linkages to agencies and other providers of geodetic data, make existing geodetic data discoverable and easily accessible, and to work toward standardization.

Group on Earth Observations (GEO)

GEO GROUP ON EARTH OBSERVATIONS

- GGOS represents the IAG in the Group on Earth Observations as a contributor to the GEO Foundational Task **GEOSS In-Situ Earth Observation Resources;**
- IAG/GGOS has been selected to be a member of the **GEO Programme Board during 2018-2020**, with Gross being the Principal Representative and Craddock acting as alternate.
- External Relations also connects the GGOS CO to the GEO Communicators Network.

UN GGIM Subcommittee on Geodesy

United Nations

- GGOS supports and, as needed, represents the IAG at the United Nations Committee of Experts on Global Geospatial Information Management (UN GGIM).
- GGOS Consortium members H. Schuh and D. Angermann participate in Subcommittee Focus Groups on behalf of the IAG, with Consortium members Gross, Craddock, and G. Johnston participating on behalf of their nations.

Committee on Earth Observation Satellites (CEOS)

CEOS
The Committee on Earth Observation Satellites

- GGOS has renewed its engagement with CEOS by appointing Craddock as the GGOS representative to their **Ad Hoc Team on the Sustainable Development Goals** (AHT SDG), which highlights the potential role for Earth observations in supporting the global indicator framework of the United Nations Sustainable Development Goals

International Council for Science (ICSU) World Data System (WDS)

ICSU
WORLD DATA SYSTEM

- GGOS, a partner member of ICSU-WDS, may play an important part in encouraging data providers of the WDS to adopt or renew their **CoreTrustSeal**, the new WDS data certification process.
- ICSU is also developing **Essential Sustainability Variables**, which would be in alignment with GGOS's own recent initiative to define Essential Geodetic Variables.

Slide provided by Allison Craddock

Bureau of Networks and Observations

- Provide a forum for the Services and Standing Committees/Working Groups to share and discuss plans, progress, and issues, meetings in conjunction with annual AGU and EGU.
- Advocate for new and increased network participation, encouraging formation of new partnerships to develop new sites, monitored the status of the networks; meetings and communications held with representatives from Russia, Italy, Brazil, Japan, Spain, France, Korea, and Saudi Arabia to discuss implementation of new stations and upgrade of legacy stations.
- Continue the Bureau's "Call for Participation in the Global Geodetic Core Network: Foundation for Monitoring the Earth System"; 19 submissions have been received covering 114 sites that include legacy sites, new technology co-location and core sites, sites under development, and sites offered for future participation; a number of new sites plan to join once they are operational.

- See: http://www.ggos.org/Components/BNO/

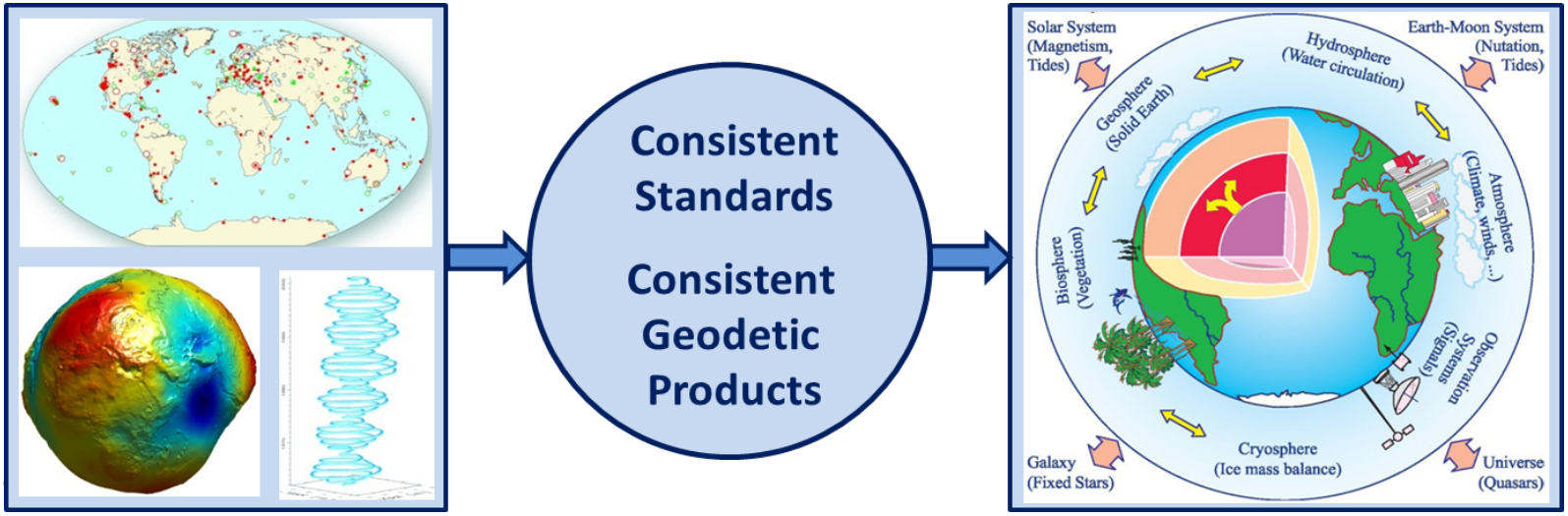
Slide provided by Mike Pearlman

GOS Bureau of Products and Standards (BPS)

The BPS supports GGOS in its key goals to obtain consistent products describing the geometry, rotation and gravity field of the Earth.

Mission and objectives

- to serve as contact and coordinating point for the homogenization of IAG/GGOS standards and products;
- to keep track of the adopted geodetic standards and conventions across all IAG components, and initiate steps to close gaps and deficiences;
- to focus on the integration of geometric and gravimetric parameters and to develop new products, needed for Earth sciences and society.

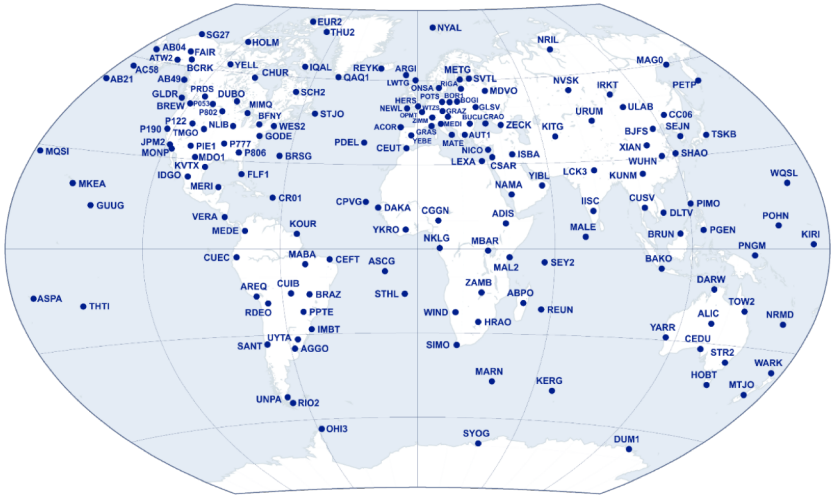


Slide provided by Detlef Angermann

FA1: Unified Height System

Advances in the IHRS/IHRF implementation

- Sep. 2016 (GGHS2016, Thessaloniki): first meeting of the WG; brainstorming and definition of action items; criteria for selection of IHRF stations.
- Oct. 2016 (GGOS Days 2016, Cambridge, MA): Preliminary station selection for the IHRF.
- Nov. 2016 – Mar. 2017: Interaction with regional and national experts about the preliminary station selection and proposal for further geodetic sites.
- Apr. 2017 (EGU2017, Vienna): First proposal for the IHRF reference network.
- May 2017: Numerical tests for the computation of potential values at the IHRF stations.
- Since Aug. 2017 (IAG-IASPEI Assembly, Kobe): Discussion on standards and conventions for the IHRS/IHRF.
- Since Feb. 2018: IHRF experiment (computation of potential values using different strategies but the same input data). First results of this experiment to be discussed at the GGHS2018 Symposium (Sep. 2018, Copenhagen).



IHRF reference network

Slide provided by Laura Sanchez

FA2: Geohazards

90% of GATEW Working Group membership has registered to attend the GTEWS2017 Workshop in Sendai.

GGOS Working Group on GNSS Augmentation for Tsunami Warning (GATEW)

Green cells signify GTEWS2017 registration as of May 1, 2017

Country	Organization	Resources	Contact	Email	GTEWS2017
Australia	GeoScience Australia	Large National Real Time GNSS Network	John Dawson	John.Dawson@ga.gov.au	
Chile	U.Chile, Department of Geophysics, CSN	Large National Real time Geodetic and Seismic Network	Sergio Barrientos, Sebastián Riquelme, Juan Baez	sbarrien@dgf.uchile.cl, sebastian@dgf.uchile.cl,jcbaez@csn.uchile.cl	
China	GNSS Research Center, Wuhan University	First Real Time Asian Analysis Center	Jianghui Geng	jgeng@whu.edu.cn	
Colombia	Geological Survey Colombia	Large Real Time GNSS Network, Regional Data Sharing with Brazil, Peru, Panama, Venezuela, COCONet Data Center	Hector Mora	hmora@sgc.gov.co	
France	Institut de Physique du Globe de Paris	Strong research in tsunami coupled ionospheric waves and tracking	Giovanni Occhipinti	ninto.a.paris@gmail.com	
Germany	GeoForschung Zentrum, Department Geoservices	Strong research and development of GNSS Early Warning including Indonesia and Oman projects	Harald Shuh, Jörn Lauterjung	schuh@gfz-potsdam.de, lau@gfz-potsdam.de	
Italy	University of Rome Geodesy and Geomatics	Initiating research in GNSS Tsunami Warning	Mattia Crespi, Augusto Mazzoni	mattia.crespi@uniroma1.it , augusto.mazzoni@uniroma1.it	
Mexico	Instituto de Geofisica, UNAM	Large National GNSS network and analysis system, COCONet Data Center	Enrique Cabral	ecabral@geofisica.unam.mx	
New Zealand	GNS Science	Large National Network	Elisabetta D'Anastasion	E.DAnastasio@gns.cri.nz	
New Zealand	Land Information New Zealand	Large National Network	Dion Hansen	DHansen@linz.govt.nz	
Sri Lanka	Survey Department of Sri Lanka	Strong interest in developing Tsunami Early Warning	P. Sangakkara,Mr A. Dissanayeke	dsggeode7c@survey.gov.lk,addsgc@survey.gov.lk	
USA	Georgia Tech	Significant focus on subduction zone activity and the generation of tsunamis	Andrew V. Newman	anewman@gatech.edu	
USA	Jet Propulsion Laboratory	Real time expertise, Ionospheric mapping, global and operations, earthquake and tsunami warning	Attila Komjathy, Tony Yuhe Song	attila.komjathy@jpl.nasa.gov, Tony.Song@jpl.nasa.gov	
USA	UNAVCO	Global GNSS networks, real time data systems, Global GNSS support	Linda Rowan	rowan@unavco.org	
USA	READI Working Group	NASA-NOAA working group developing GNSS Based Tsunami Warning	Yehuda Bock, Timothy Melbourne	ybock@ucsd.edu, tim@Geology.cwu.edu	
USA	NASA	NASA Solid Earth Science. Provides funding from GNSS Tsunami Warning development. Cooperating with NOAA in this effort.	Gerald Bawden	gerald.w.bawden@nasa.gov	

Slide provided by J. LaBrecque

Aims and Objectives of Focus Area 3

- Identification of the requirements for a proper understanding of global and regional/local sea-level rise and variability especially in so far as they relate to geodetic monitoring provided by the GGOS infrastructure.
- to establish links to external organizations (e.g. IOC) and advocate the GGOS contribution to sea level science.
- Identification of practical projects, which will demonstrate the viability, and the importance of geodetic measurements to mitigation of sea-level rise at a local or regional level.

Slide provided by Tilo Schöne

GGOS Focus Area 4: Geodetic Space Weather Research

Present Status and Progress:

1. Dr. Ehsan Forootan (Cardiff University, Cardiff, United Kingdom) became member of the GGOS Science Panel 2017-2018.
2. The three **new GGOS Joint Study Groups**
   - JSG 1: Electron density modelling
   - JSG 2: Improvement of thermosphere models
   - JSG 3: Coupling processes between thermosphere and ionosphere

   of the FA-GSWR have been installed.
3. Dr. Alberto Garcia-Rigo (UPC, Barcelona, Spain) became chair of JSG 1.
4. Dr. Andres Calabia Aibar (University of Colorado Boulder, USA) became chair of JSG 3.
5. The chair position of JSG 2 is still vacant – appropriate candidates have already been selected and approached.

Next actions:

1. Selection of the members for the two Study Groups JSG 1 and JSG 3; setting up their corresponding Terms of Reference (ToR)
2. Presentation of a poster at the EGU 2018 in Vienna, GGOS Session G2.1, April 10, 2018
3. Presentation of a poster at the IX Hotine-Marussi Symposium in Rome, June 18-22, 2018, Title: 'GGOS Focus Area on Geodetic Space Weather Research – Basic Ideas'

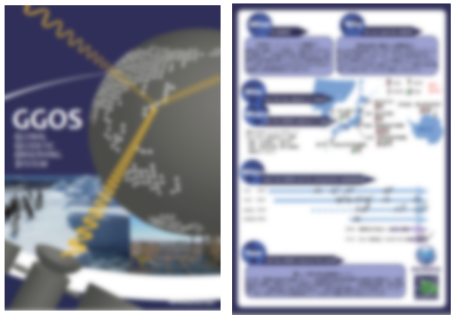
Slide provided by Michael Schmidt

GGOS Affiliate (GGOS-WG Japan)

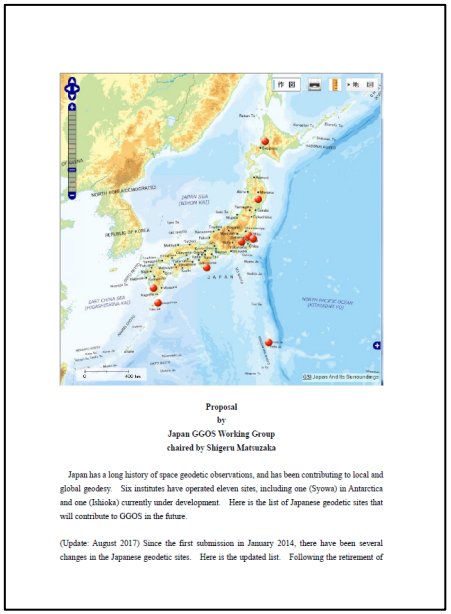
- First GGOS Affiliate accepted in 2017
- Established in 2013 under IAG Subcommittee in Science Council of Japan
- To promote and enhance information exchange and collaboration between relevant agencies
- Chair: Toshimichi Otsubo (Hitosubashi Univ.)
- Secretary: Basara Miyahara (Geospatial Information Authority of japan)

Activitiy of GGOS-WG Japan

- 2014: Status report on geodetic observatories in Japan
- 2015~: GGOS session @ JpGU 2015,2016,2017
- 2018: Special issue on GGOS in Journal of the Geodetic Society of Japan
- ~2018: GGOS Brochure in Japanese



GGOS Brochure in Japanese (under preparation)

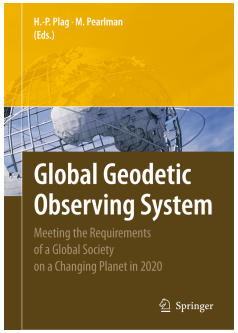


Status report submitted in 2014, revised in 2017

Slide provided by Basara Miyahara

Global Geodetic Observing System

- Requirements-setting organization for geodesy
  - GGOS 2020 book and its update
  - Essential Geodetic Variables
- Forum for international collaboration
  - Improve integrated, global geodetic infrastructure
  - Improve geodetic products
    - Unified Analysis Workshops
- Advocate for geodesy to broader community
  - Group on Earth Observations; Committee on Earth Obs. Satellites
    - Provide Earth observations (including geodetic) needed to make informed decisions
  - UN-GGIM Subcommittee on Geodesy
    - Emerging policy-making organization in geodesy
    - Emerging forum for international collaboration
- Incubator for new initiatives in geodesy
  - Unified Height System; Sea Level Change, Variability, & Forecasting
  - Geohazards; Geodetic Space Weather Research



GGOS Days 2018

GSI Headquarters
Tsukuba, Japan
October 2-4, 2018

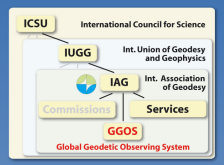
Will include excursion to
Ishioka Geodetic Observing Station

Please Attend!

IAG's Global Geodetic Observing System

GGOS
http://www.ggos.org

Markus Rothacher (GGOS Chair), Achim Helm (GeoForschungsZentrum Potsdam)
Ruth E. Neilan (GGOS Vice-Chair) (Jet Propulsion Laboratory)
Hans-Peter Plag (GGOS Vice-Chair) (University of Nevada)

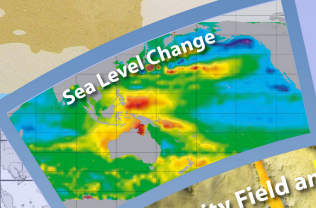


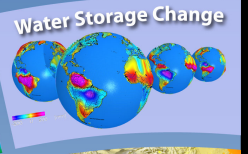

Elbe 2002 Flood

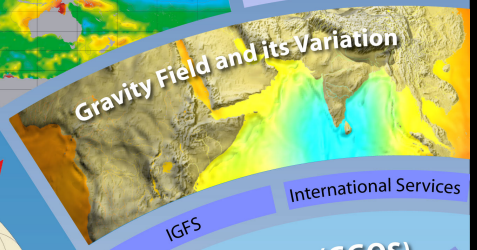

New Orleans 2005 Hurricane

Sumatra 2004 Tsunami


Kobe 1995 Earthquake


Sea Level Change

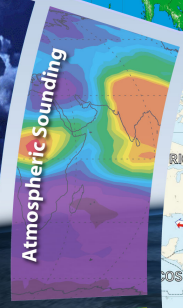

Water Storage Change


Gravity Field and its Variation

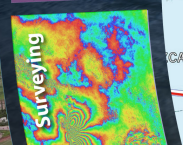

Disaster Monitoring

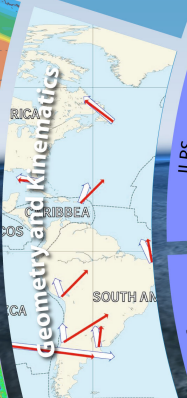

Deformations

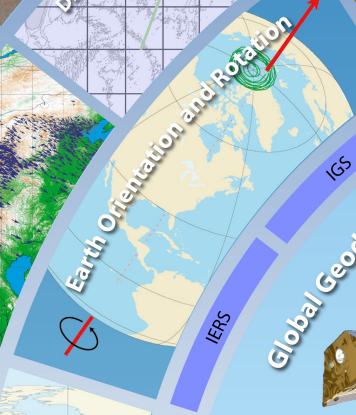

St. Helens 1980 Eruption


Atmospheric Sounding


Kainaman 2004 Mudflow


Surveying

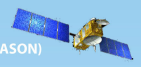

Geometry and Kinematics


Earth Orientation and Rotation

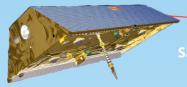
International Services
IGFS
IGS
IERS
ILRS
IVS

Global Geodetic Observation System (GGOS)

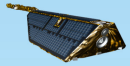

GPS, GLONASS, Galileo


Satellite Altimetry (JASON)

Geodetic Space Techniques



Satellite-to-satellite tracking (GRACE)


Atmospheric Sounding (CHAMP)


Satellite Laser Ranging


Tsunami Detection (GPS Buoy)


VLBI


IAG Services are based on more than 400 global observation stations